CENTRAL VALLEY
FLOOD MANAGEMENT
PLANNING PROGRAM

FloodSAFE
CALIFORNIA

Public Draft

2012 Central Valley Flood Protection Plan

Attachment 9D: Improving Vegetation Data

January 2012

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

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1.0 Introduction

As authorized by Senate Bill 5, also known as the Central Valley Flood Protection Act of 2008, the California Department of Water Resources (DWR) has prepared a sustainable, integrated flood management plan called the Central Valley Flood Protection Plan (CVFPP), for adoption by the Central Valley Flood Protection Board (Board). The 2012 CVFPP provides a systemwide approach to protecting lands currently protected from flooding by existing facilities of the State Plan of Flood Control (SPFC), and will be updated every 5 years.

As part of development of the CVFPP, a series of technical analyses were conducted to evaluate hydrologic, hydraulic, geotechnical, economic, ecosystem, and related conditions within the flood management system and to provide baseline data and to support formulation of system improvements. These analyses were conducted in the Sacramento River Basin, San Joaquin River Basin, and Sacramento-San Joaquin Delta (Delta).

DWR needs high-quality vegetation data to support informed planning decisions as part of the CVFPP and the associated Central Valley Flood System Conservation Strategy. To meet this need, DWR is working collaboratively with other agencies to develop a contiguous vegetation data set for the CVFPP Systemwide Planning Area. Despite the importance of this type of data, and the importance of riparian habitat in the State of California (State), no comprehensive Central Valley-wide map of riparian and floodplain vegetation has been available.

DWR is in the process of completing a seamless riparian vegetation map for the Sacramento and San Joaquin Rivers main-stems and tributaries within the CVFPP Systemwide Planning Area. Before the current effort, most riparian vegetation data sets for the study areas were incomplete, or were presented in a varying scales and resolutions. Some vegetation classifications used in earlier studies were not standardized, potentially limiting their usefulness when combined with other data sets. The current mapping efforts will provide baseline data for project impact analysis, and conservation and restoration area planning, and will enable use with other standardized vegetation data.

The purpose of this attachment is to describe the importance of high-quality vegetation data for improving flood management and ecosystem conditions in the Central Valley and to summarize other related mapping efforts. It will also describe DWR's approach, progress, and future steps for improving the quality of vegetation data.

2.0 Background and Need for Higher Quality Vegetation Data

Vegetation mapping continues to be a significant tool for quantifying natural lands and habitat, and for determining baseline habitat values. Medium- and fine-resolution vegetation maps delineate baseline natural vegetation and land uses, provide information on habitat values and connectivity, and may indicate potential for wildlife and sensitive species. Vegetation maps are important tools in natural resource and conservation planning, as well as data analysis. They provide a baseline for a wide range of data-gathering efforts.

Typical uses for vegetation mapping and delineation include identifying individual plant and animal species distributions, predicting the spread of invasive species, prioritizing land acquisitions for mitigation and restoration, identifying important wildlife corridors, setting a baseline for monitoring future impacts such as sea level rise, predicting habitat use by sensitive species, and identifying correlations (e.g., between vegetation and physical features) .

Current vegetation data may be combined with additional data sets in a Geographic Information System (GIS) and provides an important component which contributes to the baseline coverage of a study area. Such vegetation maps may be combined with soils, hydrology, and other physical features; these provide a current status of the system and enable modeling of future conditions. Vegetation data layers can help to inform planning, design work, maintenance, invasive species control, and ecological restoration. Such data document the current distribution of habitats and land uses, help establish baseline conditions for monitoring changes over time, and show the degree of connectivity and fragmentation of habitat

Mapping high-quality vegetation data provides important sets of information for improving planning for and management of flood and ecosystem conditions in the Central Valley. High-quality vegetation data are also useful for identifying both potential habitat for sensitive species and areas of potential infestations of invasive species. These data also are used to strategically identify important locations for conservation actions, such as restoration, habitat enhancement, and acquisitions.

Vegetation data are developed and used at different geographic scales to meet specific needs:

- **Medium-scale (or medium-resolution) data,** with minimum map units of about one acre, classify vegetation by plant associations and dominant species and are useful for regional-level assessments. These data simplify the complex details of localized habitat distribution and show planners and managers the larger context of vegetation patterns. Medium-resolution data can be used, for example, to strategically locate large infrastructure or development projects in ways that avoid or reduce environmental impacts, thus reducing future costs for project redesign, relocation, or mitigation. These data also help to assess landscape-level or watershed conditions and trends, and identify needs for improving regional habitat restoration and connectivity.

- **Fine-scale (or fine-resolution) vegetation data** are a more precise representation of localized vegetation distribution, with minimum mapping units of less than one acre. Fine-resolution data provide significantly more detail on vegetation structure and species relationships than medium-scale data, making these data valuable for project-level planning and management decisions. However, fine-scale data require considerably more detailed field evaluation and time investment, greater computer storage space, and longer analytical processing time than medium-scale data for the same size planning area.

Finally, although these are currently the best data available based on remote imagery, in some cases they may not always be adequate to substitute for highly detailed on-the-ground delineation. For example, identifying and quantifying shaded riverine aquatic habitat (SRA) requires more detailed ground work since there are layers of canopy and vegetation which can't be determined only from aerial photo interpretation. High-quality vegetation maps in this case can support the more detailed field studies necessary for delineating SRA.

3.0 Past Vegetation Mapping Efforts within the Central Valley

Over the years, State and federal agencies in California have funded a variety of vegetation and land cover mapping efforts. To guide the best use of DWR funding for improving vegetation data, this section evaluates these other efforts for their applicability and usefulness. Useful vegetation data must meet needs for systemwide coverage, adequate resolution of mapping units and classification types, adequate information (attributes) describing each mapping unit, and adequate accuracy.

3.1 Statewide and National Efforts

Statewide and national efforts to generate vegetation mapping data include the following:

- **Gap Analysis Vegetation Layer (Davis et al., 1998)** – This statewide dataset, completed in 1995, maps terrestrial vegetation and natural communities at a coarse scale, with a minimum map unit (MMU) of more than 250 acres. Local areas of vegetation were omitted because of the coarse resolution, and riparian vegetation was underestimated.

- **Central Valley Wetlands and Riparian Areas GIS Database (DFG, 1997)** – This data set is an inventory of wetlands, riparian areas, and associated land cover in the Sacramento and San Joaquin valleys and the Delta. Landsat satellite imagery was used to map land cover classes, such as wetland, agriculture, and uplands. Wetland and riparian features were inventoried at a coarse level but with less specificity than a field-based survey.

- **National Wetland Inventory (USFWS, 2010)** – The U.S. Fish and Wildlife Service mapped wetlands and woody riparian vegetation from aerial photographs. Vegetation was mapped with an MMU greater than one acre, and mapping of some areas of riparian habitat was omitted. This inventory is used for regional and watershed data display and analysis, rather than project-specific data analysis.

Although these efforts cover all of the CVFPP Systemwide Planning Area, they are mapped at coarser resolutions and classifications than DWR needs. The current DWR vegetation mapping effort can be used as a baseline, and

future conditions can be used to provide updated maps and measurements of restored acreage and impacts.

3.2 Central Valley-Focused Mapping Efforts

Higher resolution vegetation data coverage exists for a few portions of the CVFPP Systemwide Planning Area, but these data omit large areas of the entire flood management system. Some of the vegetation mapping efforts previously conducted in the Central Valley are listed below:

- **Sacramento River Region 2007 Sacramento River Riparian Mapping (Carlson and Funes, 2010)** – This large project covers the Sacramento River Conservation Area and was completed by the California State University, Chico, Geographical Information Center.

- **Sacramento-San Joaquin Delta – Vegetation and Land Use Classification and Map (Hickson and Keeler-Wolf 2007)** – These fine-resolution vegetation data were completed using a statewide standardized approach led by the California Department of Fish and Game (DFG). The same methodology was used that DWR will employ in developing its fine-resolution data for the Central Valley. These data cover only the legal Delta, so there is only limited overlap with the current DWR vegetation mapping effort. This map has been extensively for various planning efforts at several agencies, including the Bay-Delta Conservation Plan.

- **San Joaquin River Mapping Study (DWR, 2002)** – This study mapped riparian vegetation on portions of the main-stem San Joaquin River from Millerton Lake to the Merced River confluence. The study was field-based and transects were conducted to measure riparian vegetation. Riparian classifications are based on the Holland classification of California vegetation (Holland, 1986).

- **Central Valley Riparian Mapping Project Interpretation and Mapping Systems (California State University, Chico, 1979)** – The California Riparian Study Program was a series of studies started in 1979 that set out to map riparian areas within Central Valley depositional bottomland using aerial photographs. Work was completed at California State University, Chico, and California State University, Fresno.

4.0 Statewide Mapping Standards and Consistency

In 2000, the California Biodiversity Council (CBC) prepared a Memorandum of Understanding (MOU) among State and federal agencies to establish a cooperative vegetation and habitat mapping standard. Signatories recognized that many mapping efforts were ongoing and that these efforts could be designed to be compatible and complementary for eventually providing signatories statewide coverage of high-quality vegetation data. They also recognized the importance of vegetation mapping as a tool to provide valuable data for conservation and recreation planning and forest and economic analysis.

These statewide vegetation mapping standards (CBC, 2000) are available online at: http://ceres.ca.gov/biodiversity/vegmou.html.

DWR follows these cooperative vegetation mapping standards. The finer scale mapping effort further complies with the *Manual of California Vegetation* (Sawyer et al., 2009) and the National Vegetation Classification Standard (NVCS), as defined in the April 2003 Federal Geographic Data Committee draft standards Source (FGDC, 2008), available at http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation .

Consistency with these standards allows vegetation map data to be available for use across agencies, which, in turn, permits data sharing, provides for longevity of the data (data collected on a unique platform not consistent with others become obsolete more quickly), and for consistency with future mapping efforts and updates.

The State Wetland and Riparian Area Monitoring Program (WRAMP) outlines a standardized approach to wetland and riparian mapping within the State (Collins et al., 2006). The current DWR vegetation mapping effort is consistent with the standard methodology for WRAMP (CWMW, 2010). The statewide WRAMP effort will additionally be able to use the riparian data to contribute to their riparian model building and accuracy within the CVFPP Systemwide Planning Area.

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5.0 DWR's Approach and Progress in Improving Vegetation Data

DWR is developing high-quality vegetation data for Central Valley flood and ecosystem planning in two phases. The first phase, completed in December 2011 was to develop a medium-scale vegetation data set to help with systemwide planning. The second phase, initiated in late 2011 and proposed for completion in late 2013, will develop a fine-scale vegetation data set.

Both the medium- and fine-scale mapping of riparian vegetation for the CVFPP were based on current aerial photography and field studies. The methodology consisted of aerial photo interpretation, ground-based vegetation classifications, and GIS editing and processing. The riparian classification follows State and national standards for vegetation classification described above (CBC, 2000). The riparian classification also can be crosswalked to the widely-used Wildlife Habitat Relationship system (WHR) of habitat classification, (Mayer and Laudenslayer, 1988), allowing users to link both data systems.

5.1 Medium-Scale Map and Methodology

The recently completed effort undertaken by DWR represents the first medium-scale vegetation map to cover the entire CVFPP Systemwide Planning Area. Mapping was conducted for the main-stem Sacramento, Feather, and San Joaquin Rivers and major tributaries within the project area, as defined within the CVFPP Systemwide Planning Area. The project area covers approximately 3,315,582 acres or 5,180 square miles.

Although this map was not completed in time to be used in preparation of the 2012 CVFPP, it will be an important scientific foundation for the Central Valley Flood System Conservation Strategy, the 2017 CVFPP and for planning efforts in the interim. The map will be available for public access[1] after the 2012 CVFPP is released in early 2012. This medium-resolution product provides one- to two-acre MMU resolution for riparian areas and 10-acre resolution for urban and agricultural areas.

[1]Map data will be accessible at http:/bios.dfg.ca.gov

The medium-scale mapping effort was based in part on existing GIS riparian vegetation maps, which were prepared incrementally over the past decade for various parts of the Central Valley; field data were collected throughout the main-stems and tributary areas. Figure 5-1 illustrates an overview of the riparian map in the Feather River watershed.

The mapping method is based on aerial photo interpretation and field verification, and a standard methodology used by DFG. Existing vegetation maps were field-checked and updated to existing classification standards, and gaps in coverage were filled. Field surveys were used to validate the vegetation type and location on the ground. These vegetation plots were surveyed using the California Native Plant Society Rapid Assessment protocol (Hickson and Keeler-Wolf, 2007).

The area covered by each vegetation type or classifications was delineated in a GIS layer into polygons, which delineate the area covered by each vegetation type. These polygons were digitized using interpretation of 2009 color aerial photographs created by the U.S. Department of Agriculture's National Agricultural Imaging Program (USDA, 2009). Digitized polygons were attributed based on vegetation classifications developed in the Manual of Natural Vegetation (Sawyer et al., 2009) to the NVCS Group level (FDGC 2008). A final step included an independent validation and a random sample of plots for accuracy assessment. Figure 5-2 shows a close-up of medium-scale vegetation polygons on a local levee with typical riparian vegetation.

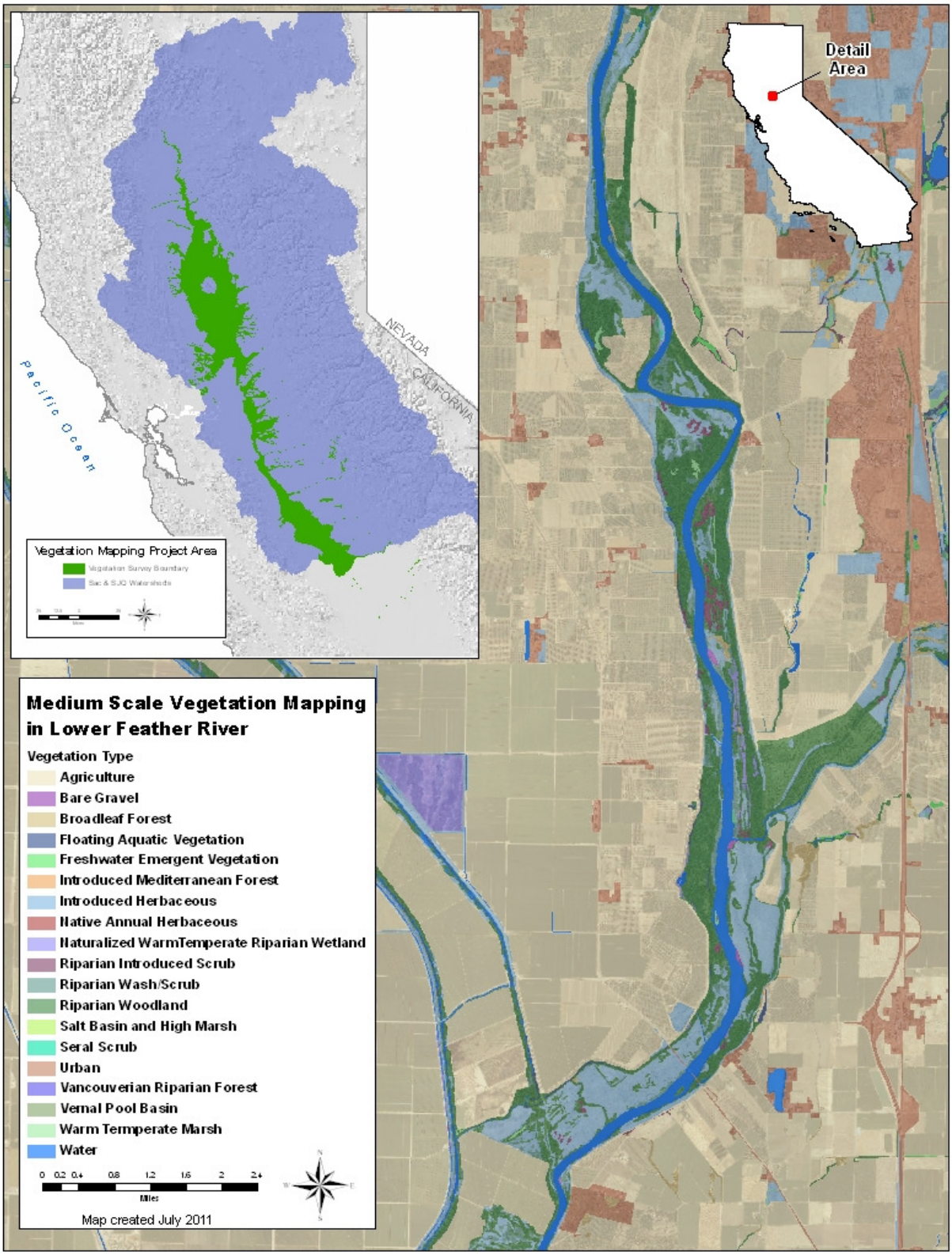

Figure 5-1. Medium-Scale Vegetation Mapping Overview for Lower Feather River

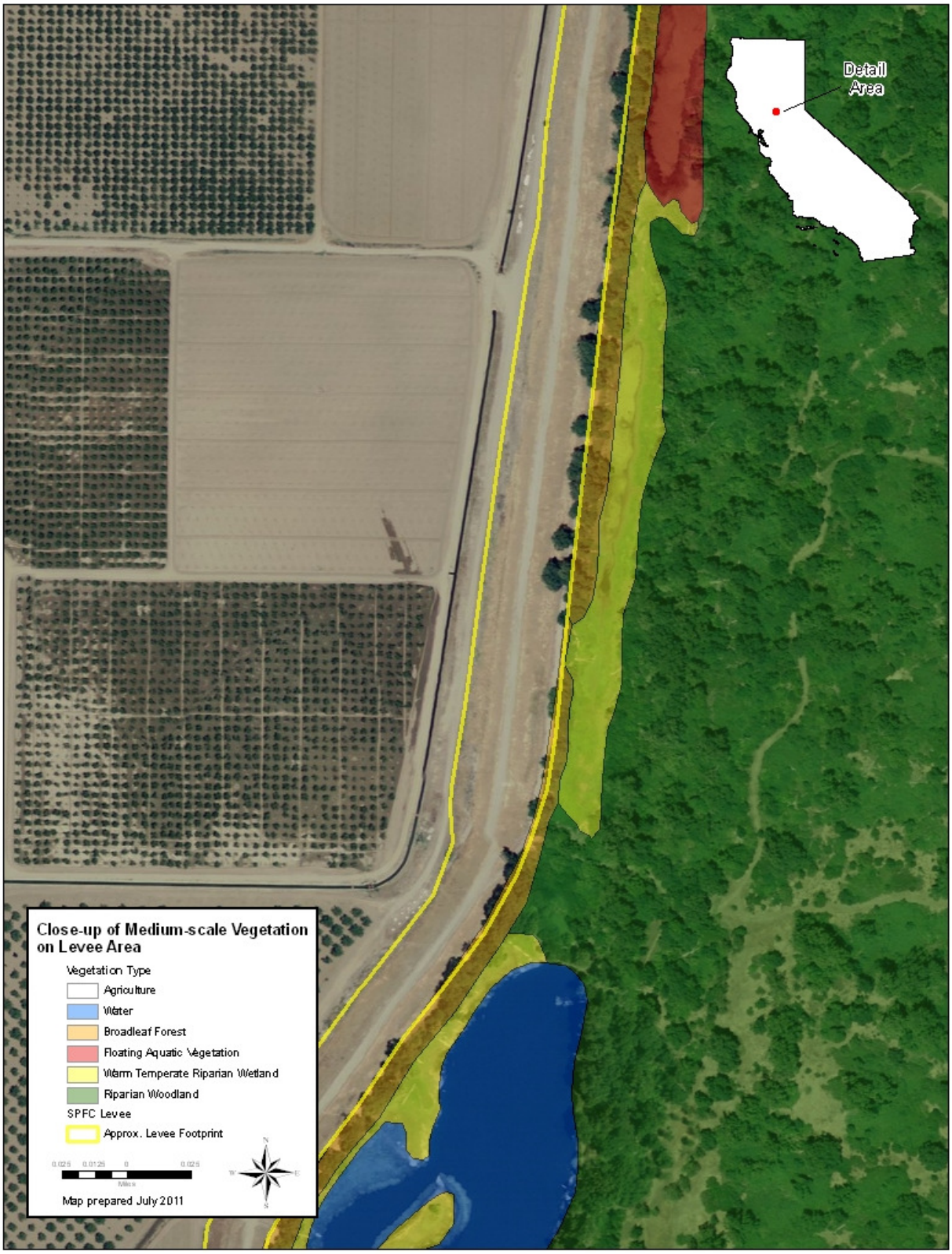

Figure 5-2. Map Application: Close-up of Medium-Scale Vegetation Polygons on Levee

5.2 Fine-Scale Mapping

DWR is currently developing fine-scale vegetation data for the CVFPP Systemwide Planning Area. Data collection began in summer 2011 and final map products and data are expected to be completed in 2013. This fine-scale vegetation mapping effort will use the statewide standardized approach for mapping fine-scale vegetation led by DFG (Hickson and Keeler-Wolf, 2007). Data will be provided at one-acre or less MMU resolution.

The fine-scale vegetation data will refine the area covered by the medium-scale data. Land use will be completed to the Anderson Level II classification (Anderson et al., 1976).

Fine-scale mapping will enable detailed area measurements of specific changes and impacts within project areas, restoration sites, or changes in land use. Components of the fine-scale map may also be used in wetland and riparian modeling efforts, such as the statewide WRAMP. The fine-scale effort will include detailed data sets on invasive species, structural components (tree and shrub cover, height, tree size), processes, and metrics for riparian function in hydrologic modeling.

These additional data will enable planning, data assessment, and impacts analysis at a detailed level. Map data can also be used for conservation planning at the species level: For example, sensitive species location data can be correlated with high, medium, or poorly suitable habitat. In addition, map data can be used to measure the extent of native vegetation on State Plan of Flood Control levees. Map data can be used to determine extent of invasive species, and the extent of selected canopy types can be differentiated and quantified according to size classes. The new riparian map coverage of the full CVFPP Systemwide Planning Area would enable regular updates, as necessary, to determine changes in vegetation status or trends.

Figures 5-3 and 5-4 provide examples of the differences between medium-scale mapping and fine-scale mapping. Figure 5- 3 shows vegetation at the more detailed fine-scale resolution. Figure 5-4 illustrates vegetation polygons mapped at the more general medium scale, with fine-scale delineations overlaid on the medium-scale mapped areas. These illustrate two vegetation alliances found in the Delta, (1) Arroyo Willow, and (2) Arroyo Willow-Bulrush-Common Reed complex unit.

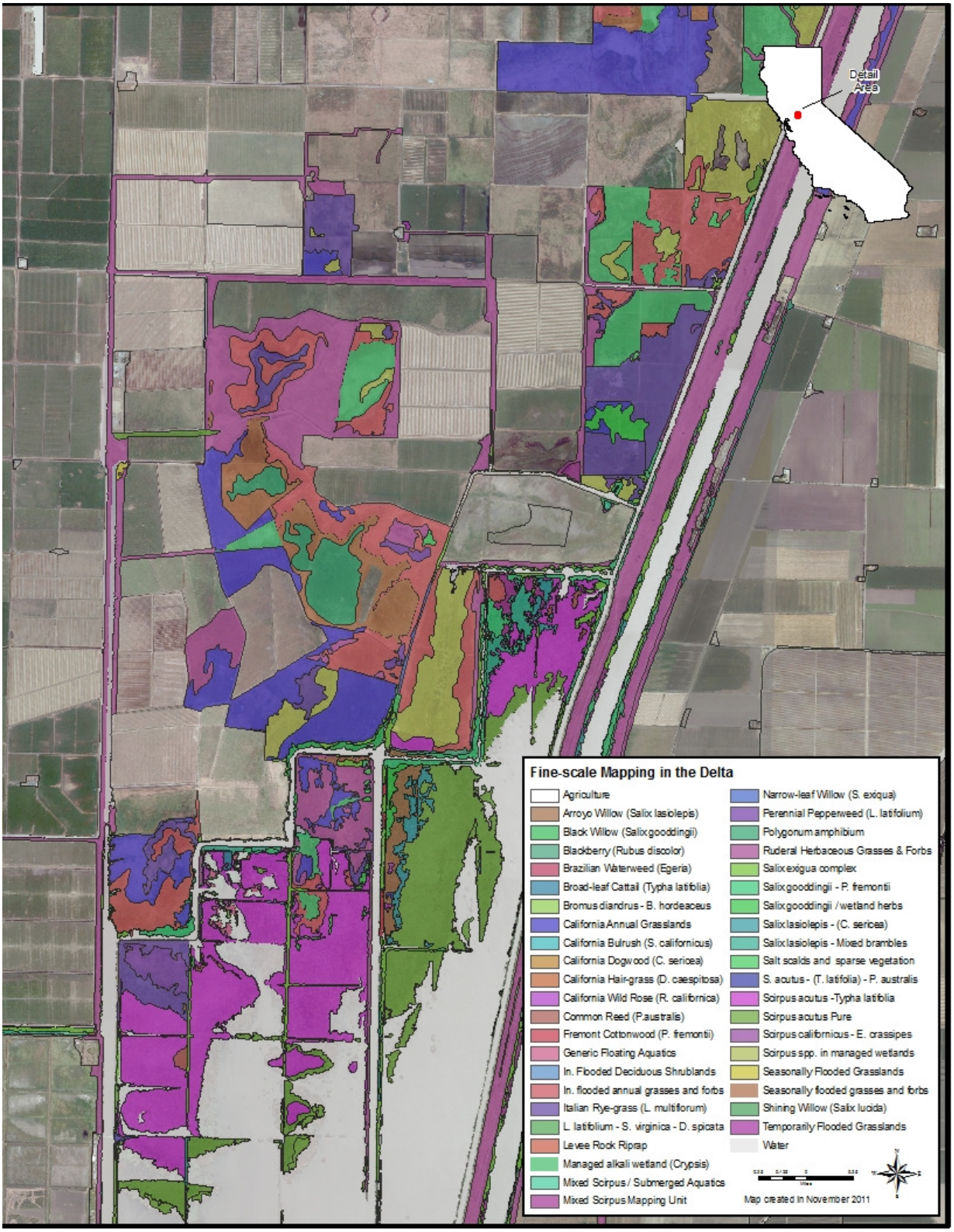

Figure 5-3. Fine-Scale Vegetation Types in the Delta Illustrating 42 Vegetation Alliances

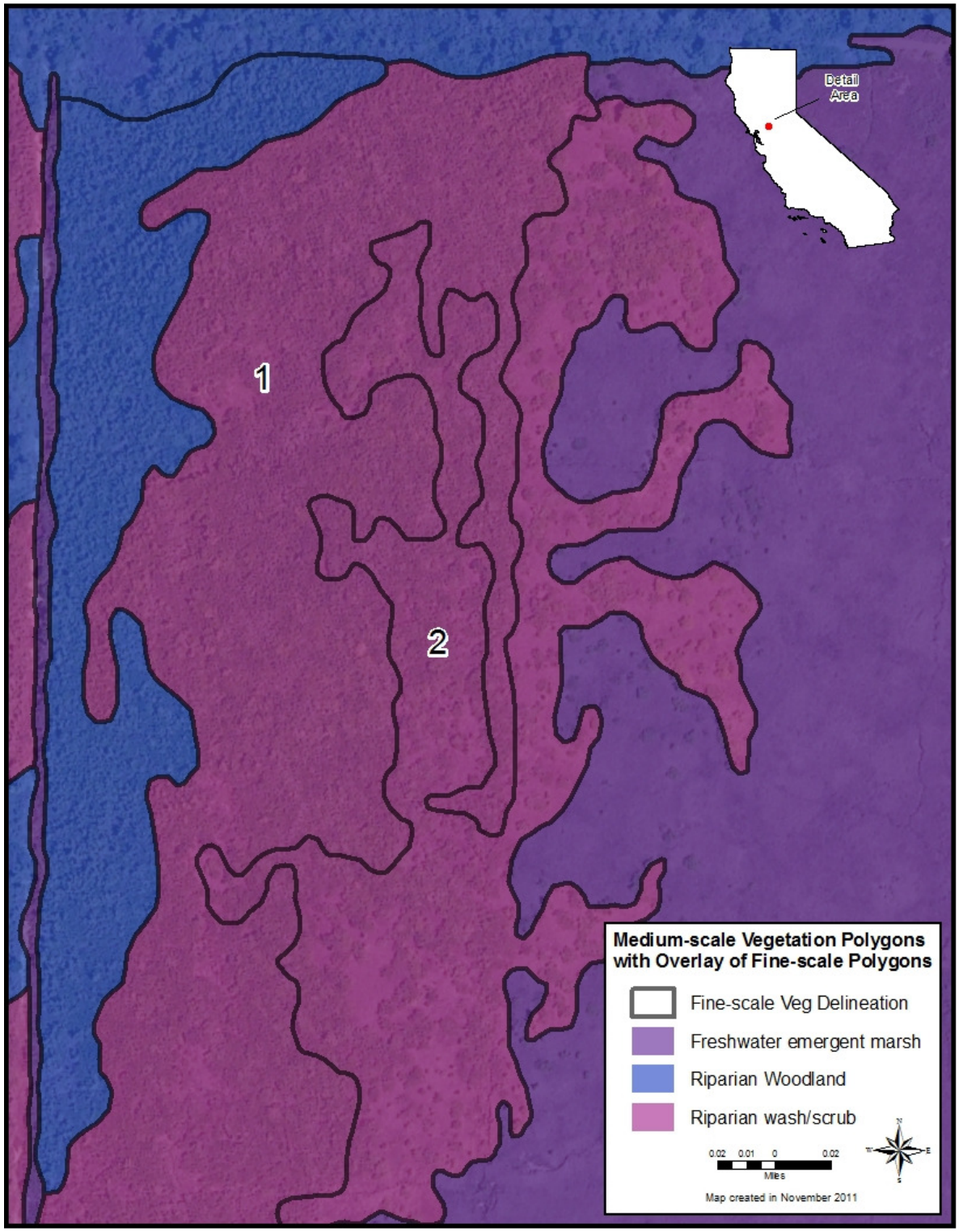

Figure 5-4. Medium-Scale Polygons of Riparian Wash/Scrub, with Overlay of Fine-Scale Delineations of (1) Arroyo Willow, and (2) Arroyo Willow-Bulrush-Common Reed Complex Unit

Vegetation composition and abundance are considered an accurate gauge for identifying important habitats and ecosystems within a given region. Vegetation community data are incorporated into natural lands conservation efforts, and continue to be an important tool for land management planning and impact analysis.

In summary, fine-scale mapping will support a variety of uses for DWR and other organizations, including but not limited to the following:

- Measuring and monitoring vegetative changes over time in the extent, diversity, and connectivity of native vegetation within the Central Valley flood management system (levees, floodways, and other facilities)
- Informing the design and implementation of flood management policies and projects to avoid and minimize adverse effects on vegetation and species
- Identifying priority areas for restoration and conservation actions
- Conducting conservation planning for specific species and modeling their potential distribution based on habitat. For example, sensitive species location data can be correlated with highly, medium, or poorly suitable habitat (Figure 5-5)
- Supporting wetland and riparian modeling efforts such as the statewide WRAMP
- Determining the extent of invasive plant species

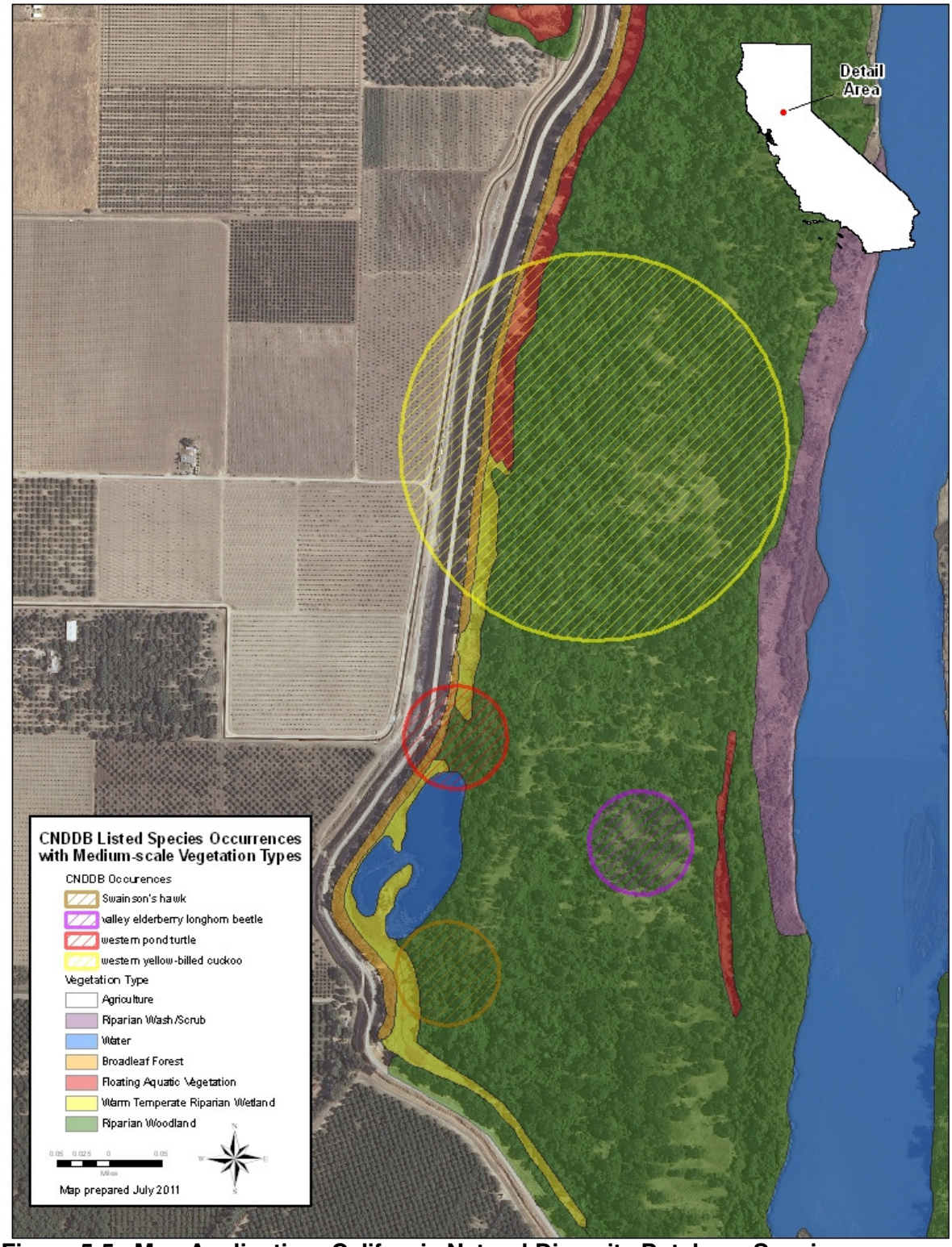

Figure 5-5. Map Application: California Natural Diversity Database Species Occurrences with Associated Medium-Scale Vegetation Types

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7.0 Acronyms and Abbreviations

CVFPP ..... Central Valley Flood Protection Plan
Delta ..... Sacramento-San Joaquin Delta
DFG ..... California Department of Fish and Game
DWR ..... California Department of Water Resources
GIS ..... geographic information system
MMU ..... minimum map unit
MOU ..... Memorandum of Understanding
NVCS ..... national Vegetation Classification System
State ..... State of California
WHR ..... Wildlife Habitat Relationship
WRAMP ..... Wetland and Riparian Area Monitoring Program

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